REMARKS

In response to the Office Action mailed January 15, 2003, Applicant respectfully requests reconsideration in light of the foregoing amendments to the claims, the following remarks and two-month request to extend the time to respond.

Claims 1-7 are presented for reconsideration. Claims 1-3 and 7 stand rejected under 35 USC § 103(a) as being unpatentable over Waldron et al. (US Patent No. 6,168,067) in view of Bottiglia (US Patent No. 4,296,300). The Examiner contends that it would have been obvious to one of ordinary skill in the art to modify the teachings of Waldron et al. with the teachings of Bottiglia by utilizing a cryogenic cooling fluid, namely nitrogen, in order to result in an abrupt temperature change that does not disturb the joint workpieces.

Applicant submits that the invention as currently claimed is not obvious over the combinations suggested by the Examiner. Applicant's invention is a method of friction stir welding together at least two metallic workpieces including the step of applying at or adjacent a heated welding zone a cryogen in the form of at least one jet thereby reducing the tensile stresses in the welding zone and creating compressive stresses in the welding zone.

Waldron et al. teaches friction stir welding processes. In this process, a first and second structural member are solution heat treated at a first pre-determined temperature schedule. The first and second structural members are then quenched to a pre-determined temperature at which time they have an incomplete temper and are in a non-equilibrium state. The first and second structural members are then joined to form a structural assembly by the friction stir welding along their interface and prior to precipitation heat treating of the structural assembly. This precipitation heat treating results in hardening by aging the structural assembly at a second pre-determined temperature schedule which will result in stabilizing the material properties and completing the temper of the structural assembly. The structural assembly is then

further cooled to ambient temperatures for use in manufacturing operations. Quenching can be employed simultaneously with the joining step and in one embodiment a liquid coolant jet of gaseous coolant can be employed as the quench.

Bottiglia teaches a method and apparatus for welding or brazing of a sheet metal or plate covered with a temperature degradable protective coat which can be zinc or plastic. In this method, a cooling fluid such as a cryogenic fluid at very low temperature is performed on the coating in a zone on the back of the welding zone. This will limit the effect of the cooled fluid to the back of the welding zone any disturbance in the welding operation. Applicant contends that this combination does not teach or suggest the invention as presently claimed.

The Examiner's attention is directed to page 5, beginning line 26-31, following through to page 6, lines 1 and 2 of Applicant's specification, as well as the accompanying drawing Figure 3. Residual stress measurements performed by a neutron scattering methods were made longitudinally through the finished weld. These clearly show the advantageous affect of cryogenic cooling on stresses in the central weld zone. Figure 3 demonstrates the difference between weld samples made with and weld samples made without cryogenic cooling and in accordance with the present invention. A substantial reduction in the tensile stresses in the weld zone and increase in compressive stresses in the weld zone are manifested by the present invention. Without cryogenic cooling in accordance with this invention, these advantages and unexpected results are not present.

Waldron et al. does not disclose a cryogenic coolant nor do they disclose the surprising and unexpected result of reduced tensile stress and increased compressive stress. In fact, Waldron et al. requires a tempering step as noted in column 6, lines 15-29, to be performed after the friction stir welding step.

Bottiglia relates to arc welding. The heating pattern in the work pieces created during arc welding is entirely different from that created during frictional stir welding.

There is no suggestion in Bottiglia that the liquid nitrogen can be used to adjust the stress patterns in the weld zone. Rather, it is employed to prevent a protective coat from melting or being volatilized. Bottiglia teaches applying to the back of the weld zone a cryogenic coolant to cool the coating of the metal pieces to be joined. There is no teaching nor suggestion in this combination of references to utilize a cryogen in the form of a jet applied at or adjacent the heated welding zone to join two metallic workpieces by friction stir welding Nor is there any suggestion of achieving reduced tensile stresses and creating compressive stresses in the welding zone. This is an advantageous and desirable result and completely unexpected. As such, claims 1-3 and 7 are not obvious over the suggested combination. Reconsideration and reversal of this rejection are respectfully requested.

Claim 4 stands rejected under 35 USC §103(a) as being unpatentable over Waldron et al. in view of Bottiglia as applied to claim 2 above and further in view of Soviet Union Patent SU-414066. Claim 4 claims that the liquid cryogen can be argon.

As Applicant has contended above, the present invention as claimed in claim 1 is not obvious over the combination of Waldron et al. in view of Bottiglia. Applicant submits that his claim 4 is also not obvious over that combination and further in view of the Soviet Union patent. The Soviet Union patent teaches arc welding. In electric arc welding, the weld metal is transferred in molten typically droplet form from a welding wire or an electrode to the site of the weld. The molten metal fuses at the site of the weld to join one workpiece to another.

This process is different from friction stir welding where a tool is employed to plastacize the regions of the two workpieces in the vicinity of the welds so that they join together. There is no melting of metal and unlike the electric arc welding process, heat is generated internally in the workpieces and is dissipated outwardly. Both of these processes are unique and different and a person skilled in the art of welding metal pieces would not have expected the thermal stress pattern in friction stir welding to have been the same as the thermal stress pattern in electric arc welding. Accordingly,

without this appreciation there is no suggestion to look to the electric arc welding process of the Soviet Union patent to employ argon as the cooling fluid in a friction stir welding process. As such, this combination of references does not teach or suggest the invention as claimed in claim 4. Reconsideration and reversal of this rejection are respectfully requested.

Claims 5 and 6 stand rejected under 35 USC §103(a) as being unpatentable over Waldron et al. in view of Bottiglia as applied to claim 1 above and further in view of Terai et al. The Examiner contends that it would have been obvious to one having ordinary skill in the art to modify the teachings of Waldron et al. in view of Bottiglia with the teachings of Terai et al. in order to provide a process of welding without softening or crack formation at the heat effected portion of the welded metal. Terai et al. teaches welding of high tension steel by metal arc inert gas welding by contacting the weld metal with a suitable coolant.

Applicant contends that the invention as claimed in claims 5 and 6 whereby the cryogen is a solid carbon dioxide or a mixture of solid carbon dioxide and a liquid cryogen are not taught by this adjusted combination.

The Terai et al. process is concerned with toughening the weld metal. Waldron et al. cools to reduce the size of the heat effected zone. These are two distinct problems and not analogous. Further, Terai et al. teaches that the subzero treatment is performed after the weld has been made and is not part of the welding method step itself as claimed in Applicant's claim 1. These are two distinct welding processes that concern two different problems. In light of the unexpected results achieved by Applicant's invention, there is no reason to combine Waldron et al and Bottiglia and further Terai et al. to utilize solid carbon dioxide or a mixture of solid carbon dioxide and liquid cryogen as the cryogen in Applicant's invention. Without this suggestion there is no reason to combine the references to arrive at Applicant's claimed invention. Reconsideration and reversal of this rejection are respectfully requested.

For these reasons, Applicant submits that the invention as claimed defines patentable subject matter and is in condition for allowance. Prompt favorable action to that end is accordingly solicited.

The Examiner is invited to call the undersigned should any issue arise during reconsideration of the present application.

Respectfully submitted,

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